Chapter I1: Background

This case study presents the results of an analysis performed by EPA to assess the potential benefits of reducing impingement and entrainment (I&E) at cooling water intake structures (CWIS) at the Detroit Edison Monroe Power plant, located at the mouth of the River Raisin on the western shore of Lake Erie (Figure I1-1). Section I1-1 of this background chapter provides a brief description of the facility, Section I1-2 describes the environmental setting, and Section I1-3 presents information on the area's socioeconomic characteristics.

Chapter Contents

I1-1 Overview of Monroe Facility

The Detroit Edison Monroe Power Plant is a four-unit, 3,293 MW fossil fuel, steam electric power plant (Cole, 1978; Goodyear, 1978; Jude et al., 1983). The facility is located where the River Raisin enters Lake Erie, just north of the J.R. Whiting facility, evaluated in Part H of this case study document (Figure I1-1). The first unit went online in 1971, and all four generating units were completed by 1974. Each unit has four circulating water pumps, each of which is capable of a flow of 7.3 m^3/sec (116,000 gpm). Monroe is one of the largest fossil fuel burning power plants in the United States (Detroit Edison, 2002).

Monroe operates a once-through cooling system (Goodyear, 1978). The cooling water intake draws a maximum flow of 85 m^3/sec (3,000 cfs) (Cole, 1978). The 100 m (328 ft) long cooling water intake channel is located about 650 m (2,133 ft) upstream from the mouth of the River Raisin (Goodyear, 1978). The intake has two screenhouses and 12 circulating water pumps (Jude et al., 1983). Each pump is equipped with trash racks with vertical bars spaced 7.6 cm (3in.) apart, and a traveling screen with 1 cm (0.4in.) openings (Goodyear, 1978). The traveling screens normally rotate once each 8 hours, but will rotate at a higher speed when debris restricts flow (Jude, et al., 1983). The cooling water discharge canal, which is 1.8 km (1.1 mi) long and 171 m (561 ft) wide, empties into Plum Creek just upstream of its confluence with Lake Erie approximately 2.5 km (1.6 mi) south-southwest of the mouth of the River Raisin (Goodyear, 1978).

Monroe uses a fish return system to divert fish from the intake channel (Jude et al., 1983; Dodge, 1998), reducing impingement by an estimated 60 percent (Dodge, 1998). Fish and debris are diverted by the traveling screens to a pump, and transported into a series of pipes that discharge into Lake Erie east of the plant.

The cooling water design flow of the Monroe plant of 1,975 MGD is 4 times greater than the River Raisin's average flow (Dodge, 1998). During most of the year, the entire flow of the river is withdrawn, and Lake Erie water is drawn upstream to the plant to provide the additional water required, reversing the flow of the river at its mouth (Goodyear, 1978; Cole, 1978).

❖ ***Ownership Information***

Monroe is a regulated utility plant owned by Detroit Edison, a subsidiary of DTE Energy Company. DTE Energy is an energy holding company with over 9,100 employees. The firm owns or controls over 11 million megawatts of electric generating capability. In 2001, DTE Energy posted sales of $7.8 billion. 2000 electricity sales were 55 million MWh (Hoover's Online, 2002; DTE Energy, 2002).

It began commercial service in 1969 and currently operates four coal-fired steam-electric units and five oil-fired internal combustion turbines. Monroe had 345 employees in 1999 and generated 18.3 million megawatt hours (MWh) of electricity. Estimated baseline revenues in 1999 were $1.4 billion, based on the plant's 1999 estimated electricity sales of 17.2 million MWh and the 1999 company-level electricity revenues of $81.59 per MWh. Monroe's 1999 production expenses totaled $284 million, or 1.553 cents per KWh, for an operating income of $1.1 billion.

Figure I1-1: Location of Monroe Power Plant on the River Raisin and Lake Erie. J.R. Whiting Power Plant is just south of Monroe Power Plant

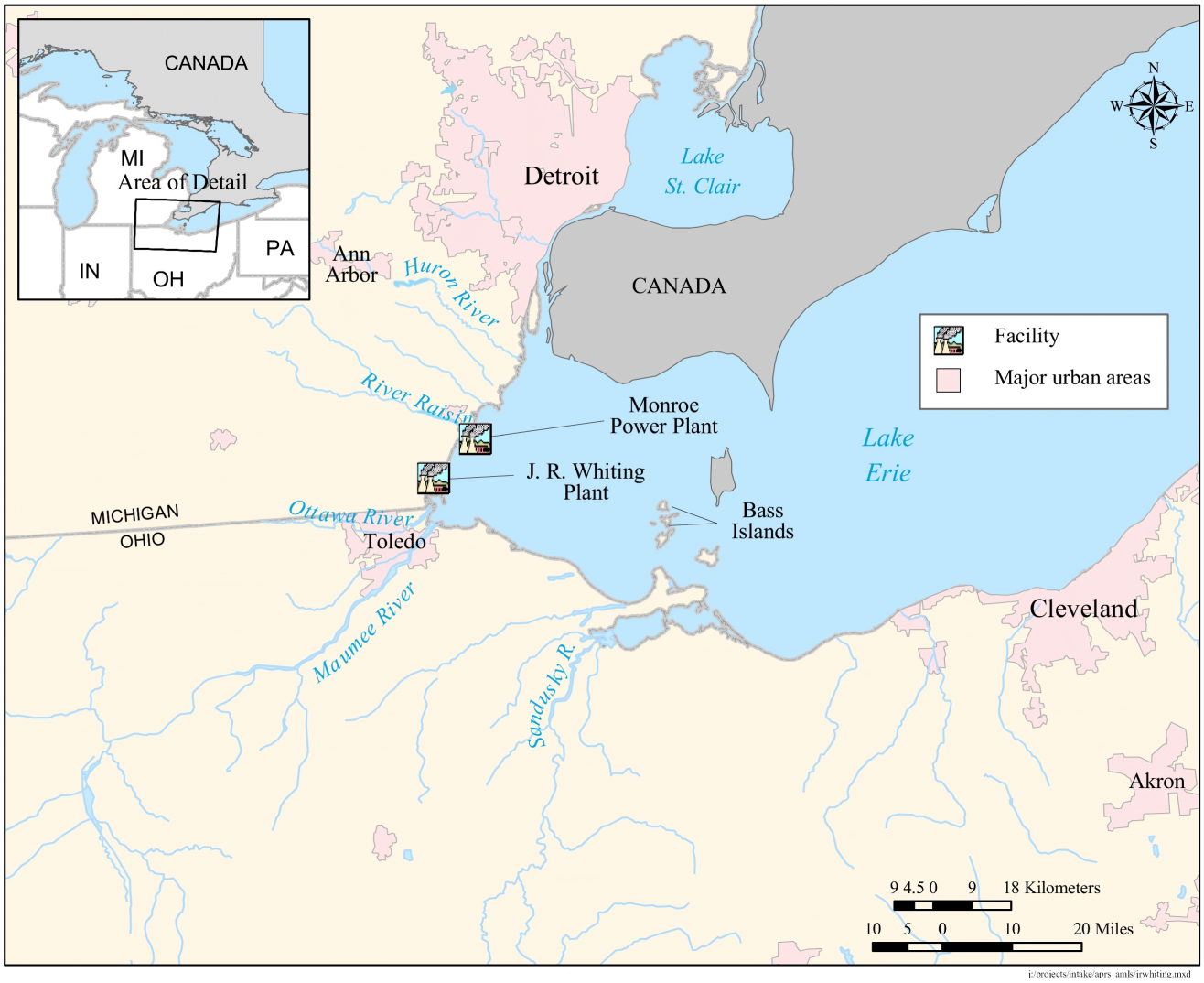

Table I1-1 below summarizes the plant characteristics of the Monroe plant.

Table I1-1: Summary of Monroe Plant Characteristics (1999)

	Monroe
Plant EIA Code	1733
NERC Region	ECAR
Total Capacity (MW)	3,293
Primary Fuel	Coal
Number of Employees	345
Net Generation (million MWh)	18.3
Estimated Revenues (billion)	$1.4
Total Production Expense (million)	$284
Production Expense (¢/KWh)	1.553¢
Estimated Operating Income (billion)	$1.1

Notes: NERC = North American Electric Reliability Council
ECAR = East Central Area Reliability Coordination Agreement
Dollars are in $2001.
Source: Form EIA-860A (NERC Region, Total Capacity, Primary Fuel); FERC Form-1 (Number of Employees, Net Generation, Total Production Expense).

I1-2 Environmental Setting

The Monroe plant withdraws water from both the River Raisin and Lake Erie. The following section focuses on the River Raisin to avoid repetition of information in Part H, the case study of J.R. Whiting. Readers seeking more information on Lake Erie are referred to Chapter H1 of Part H of this document.

I1-2.1 The River Raisin

The River Raisin drains approximately 2,770 km^2 (1,070 mi^2) in Michigan and northwestern Ohio (Dodge, 1998; USGS, 2001b). The mainstem of the river is about 240 km (150 mi) long, and the drop in elevation is about 146 m (480 ft) from the headwaters to the mouth (Dodge, 1998). The average discharge measured at a station approximately 19 km (12 mi) upstream from the mouth is 21 m^3/sec (741 cfs). The annual flow pattern is representative of a snowmelt-fed river, with high flows in March and April and low flows in July through October. It is believed that the river was named "Raisin" by French explorers who discovered plentiful grapevines growing along its banks.

The River Raisin has been affected by many factors over time (Dodge, 1998). Agricultural activity has contributed to flow instability and erosion, which in turn have altered the channel structure. In addition, agricultural land use contributes to sedimentation problems, altered temperature regimes, and nutrient loading. Point source pollution from industrial and municipal sources was a problem for many years, but has been dramatically reduced since the 1970's. Despite the potential for recreational use, public perception of the river as polluted, with limited access and poor fishery management mean that it is not heavily used.

The lower portion of the River Raisin was identified by the International Joint Commission as one of Michigan's 14 Areas of Concern (AOCs) because of polychlorinated biphenyl (PCB) and metal contamination of fish and sediments (Dodge, 1998). The River Raisin AOC is defined as the lower portion of the river from the Winchester Bridge Dam in Monroe, extending 0.8 km (0.5 mi) out into Lake Erie, and 1.6 km (1 mi) north and south along the nearshore zone of the lake (Dodge, 1998; U.S. EPA, 2001b).

I1-2.2 Aquatic Habitat and Biota

The lower River Raisin has an average gradient of 0.91 m per km (3.0 ft per mi), and a firm stream bed composed of cobble, rock, sand and limestone bedrock (Dodge, 1998). Because of the bedrock substrate, much of the river is usually shallow and wide. Overall, the river has a diversity of benthic macroinvertebrate and fish species. The northern clearwater crayfish (*Orconectes propinquus*) is found throughout the river. The lower River Raisin once supported 20 species of mussels, but a recent survey found only four species.

A survey conducted by the Michigan Department of Natural Resources in 1985 identified 36 fish species in the lower reach of the river (Dodge, 1998). Smallmouth bass were abundant, although they are not found in the middle reaches because of the shallow gradient there. Lake Erie fish are not typically found in the River Raisin, because access is restricted by a series of dams.

Many of the fish identified in I&E studies at the Monroe Plant (see Table I3-1) are common to the River Raisin (Dodge, 1998). These species include spotfin shiner (*Cyprinella spiloptera*), emerald shiner (*Notropis atherinoides*), common carp (*Cyprinus carpio*), bluntnose minnow (*Pimephales notatus*), white sucker (*Catostomus commersoni*), northern hog sucker (*Hypentelium nigricans*), bullheads (*Ameiurus* spp.), northern pike (*Esox lucius*), muskellunge (*Esox masquinongy*), rainbow trout (*Oncorhynchus mykiss*), pumpkinseed (*Lepomis gibbosus*), largemouth bass *(Micropterus salmoides*), crappies (*Pomoxis* spp.), yellow perch (*Perca flavescens*), logperch (*Percina caprodes*), and walleye (*Stizostedion vitreum*).

Other species, particularly those impinged and entrained most frequently at the plant, are most likely drawn from Lake Erie (Dodge, 1998). These species include gizzard shad (*Dorosoma cepedianum*), alewife (*Alosa pseudoharengus*), rainbow smelt (*Osmerus mordax*), burbot (*Lota lota*), freshwater drum (*Aplodinotus grunniens*), and white bass (*Morone chrysops*).

Species of special concern identified by the Michigan Natural Features Inventory (MNFI) found in the River Raisin include the black redhorse (*Moxostoma duquesnei*), brindled madtom (*Noturus miurus*), and pugnose shiner (*Notropis anogenus*). Threatened species identified by MNFI are creek chubsucker (*Erimyzon oblongus*), eastern sand darter (*Ammocrypta pellucida*), silver shiner (*Notropis photogenis*), and southern redbelly dace (*Phoxinus erythrogaster*).

I1-2.3 Major Environmental Stressors

Human activity in the River Raisin basin has led to a number of major stresses on the aquatic environment (Dodge, 1998). Dam construction and habitat alteration have affected habitat quality on the river. Prior to the 1970's, extensive point source pollution from municipal and industrial sources, particularly paper mills, resulted in PCB and metal contamination of the sediments and biota in the river. Fish communities have also been affected by stocking of species such as common carp and rainbow trout, as well as accidental introductions of invasive species.

a. Habitat alteration

The River Raisin has experienced extensive modification over time (Dodge, 1998). There are 22 dams on the river mainstem, 38 dams on tributaries, and numerous small dams on smaller streams. The construction of dams has altered the flow regime of the river and eliminated much of the highest gradient habitat in the mainstem. Approximately 94 percent of the River Raisin basin is devoted to agricultural use. Activities associated with the extensive agricultural development in the basin such as deforestation, channelization and wetland drainage have reduced the quality and diversity of aquatic habitat. Although urban land use is minimal (estimates range from 2 to 3 percent), development is increasing and affects the flow regime of the river.

River Raisin habitat for *potamodromous* fish (fish that migrate from lakes up rivers, like salmon, walleye, and white bass) has been eliminated by the combination of the large water withdrawals by the Monroe power plant and the series of dams in the lower river (Dodge, 1998). While spring spawning runs of walleye and white bass have increased dramatically in other western Lake Erie tributaries, they are absent in the River Raisin.

b. Introduction of nonnative species

The introduced zebra mussel became established in large numbers in Lake Erie and its tributaries in the late 1980's and early 1990's (U.S. EPA, 2000). Zebra mussels have altered habitat, food web dynamics, energy transfer, and nutrient cycles in the lakes. However, filtering by zebra mussels has apparently contributed to a dramatic increase in Lake Erie's water clarity. A preferred course of action on how to deal with the zebra mussels has not yet been established by the Lake Erie Lakewide

Management Plan Committee (U.S. EPA, 2000). Zebra mussels have been found in headwater lakes of the River Raisin (Dodge, 1998).

Another invasive species of concern in the River Raisin is the rusty crayfish (*Oronectes rusticus*), an aggressive species that outcompetes native crayfish and is a predator of fish eggs. Although sea lamprey (*Petromyzon marinus*) is an invasive species of concern in Lake Erie, it has not been found in the River Raisin (Dodge, 1998).

c. Overfishing

Overfishing is not a significant stressor on the River Raisin (Dodge, 1998). While major sport fish like largemouth bass are present and other species like smallmouth bass, muskellunge, rainbow trout, and walleye are stocked, fishing pressure on the lower River Raisin is only light to moderate. This may be because river fishing is more difficult than nearby lake fishing, because there are competing uses, and because of the number of dams along the river, which impede passage of boats.

d. Pollution

Discharges to Lake Erie and its tributaries of persistent toxic chemicals were banned in the 1970's, but effects of these historical discharges continue to linger (U.S. EPA, 2000). Water quality in the River Raisin was historically affected by both industrial point source pollution and agricultural nonpoint source pollution. Today, sediments, water, and biota are contaminated with PCBs and metals such as zinc, chromium, and copper (Dodge, 1998; U.S. EPA, 2001b).

The presence of PCBs has resulted in fish consumption advisories being issued for the River Raisin and Lake Erie (see Table I1-2; MDCH, 2001).

Table I1-2: State of Michigan Fish Consumption Advisories for the River Raisin and Lake Erie, 2001[a]

	Fish Length (in.)								
	6-8	8-10	10-12	12-14	14-18	18-22	22-26	26-30	30+
River Raisin (below Monroe Dam)									
Carp	◆	◆	◆	◆	◆	◆	◆	◆	◆
Freshwater drum	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■
Smallmouth bass					▼/❖	▼/❖	▼/❖	▼/❖	
White bass	▲/❖	▲/❖	▼/❖	◆	◆	◆			
Lake Erie									
Carp	◆	◆	◆	◆	◆	◆	◆	◆	◆
Catfish	◆	◆	◆	◆	◆	◆	◆	◆	◆
Chinook salmon			▲/■	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■
Coho salmon			▲/■	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■
Freshwater drum	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼
Lake trout			▲/❖	▲/❖	▲/❖	▲/❖	▲/❖	▲/❖	▲/❖
Rainbow trout			▲/■	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■
Smallmouth bass					▲/■	▲/■	▲/■	▲/■	
Walleye				▲/▼	▲/▼	▲/▼	▲/■	▲/■	▲/■
White bass	▲/■	▲/■	▲/■	▲/■	▲/■	▲/■			
Whitefish	▼/◆	▼/◆	▼/◆	▼/◆	▼/◆	▼/◆	◆	◆	◆
White perch	▲/■	▲/■	▲/■	▲/■					
Yellow Perch	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼	▲/▼			

◆ = No consumption.
❖ = Limit consumption to 6 meals (½ pound) per year.
■ = Limit consumption to 1 meal (½ pound) per month.
▼ = Limit consumption to 1 meal (½ pound) per week.
▲ = Unlimited consumption

[a] If there is only one symbol it is the advice for the whole population. When two symbols are shown, the first is the advice for the "general population" and the second is the advice for "children age 15 and under and women who are pregnant, nursing, or expect to bear children."

Source: MDCH, 2001.

e. Surface water withdrawals by CWIS

Steam electric power generation accounts for 68 percent of all surface water withdrawals from Lake Erie and its surrounding watersheds in the United States (USGS, 1995). The watersheds draining into the western Lake Erie hydrologic subregion are more heavily used by cooling water intake structures, which represent 92 percent of all surface water withdrawals.

I1-3 SOCIOECONOMIC CHARACTERISTICS

The Monroe plant is located in Monroe County, Michigan, a rural county bordered to the east by Lake Erie and to the north and south by more urban counties (Wayne County, Michigan, and Lucas County, Ohio). In 2000, Monroe had a population of 145,945, a high rate of home ownership, and a higher median income than surrounding counties (U.S. Census Bureau, 2001). The socioeconomic characteristics of Monroe and neighboring counties are summarized in Table I1-3.

Table I1-3: Socioeconomic Characteristics of Monroe and Neighboring Counties

	Monroe County, MI	Wayne County, MI	Lucas County, OH
Population in 2000	145,945	2,061,162	455,054
Land area in 2000, km^2 (mi^2)	1,427 (551)	1,590 (614)	881 (340)
Persons per square mile, 2000	265	3,357	1,338
Metropolitan Area	Detroit, MI	Detroit, MI	Toledo, OH
Median household money income, 1997 model-based estimate	$48,607	$35,357	$37,064
Persons below poverty, percent, 1997 model-based estimate	7.60%	18.00%	13.60%
Housing units in 2000	56,471	826,145	196,259
Homeownership rate in 2000	81.00%	66.60%	65.40%
Households in 2000	53,772	768,440	182,847
Persons per household in 2000	2.69	2.64	2.44
Households with persons under 18 years in 2000	39.10%	37.70%	34.10%
High school graduates, 25 and older in 1990	60,968	926,603	221,052
College graduates, 25 and older in 1990	8,655	180,822	49,393

Source: U.S. Census Bureau, 2001.

I1-3.1 Major Industrial Activities

Monroe County produces agricultural products such as soybeans, grains, corn, sugar beets, potatoes, and alfalfa, and industrial processes such as auto parts manufacturing, metal fabrication, cement, packaging, and glass production (InfoMI, 2001). The city of Monroe is the county seat and the largest city in the county. Industrial activity in the city is dominated by steel production, paper products, furniture, electrical power and auto parts.

I1-3.2 Commercial Fisheries

There is no commercial fishing on the River Raisin. In Lake Erie, commercial fishing generated between $2 million and $3 million of revenue per year over the last decade (USGS, 2001c). A small share of this catch comes from Michigan waters. Tables I1-4 and I1-5 show the pounds harvested and the revenue generated for the Michigan Lake Erie commercial fishery from 1985 to 1999. Despite fish consumption advisories, carp is the most important commercial species, comprising 72 percent of the catch and 51 percent of revenues over this 15-year period. Channel catfish, quillback, and bigmouth buffalo make up most of the remaining harvest and revenue (USGS, 2001c).

Table I1-4: Pounds of Commercial Landings in the Michigan Waters of Lake Erie, 1985-1999

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gizzard shad	878,000							2,845	395	2,103	23	36,996	24,494	4,988	6,200
Brown bullhead	7,340	7,687	4,462	5,421	3,572	488	704	444	844	659	827	828	744	2,139	7,050
Channel catfish	9,253	11,183	39,603	15,208	11,481	2,025	1,941	2,929	9,152	5,760	16,168	24,969	17,936	16,573	7,561
White perch							8	10			64	45	4		
White bass	4,764	1,397	4,142	1,049	991		19	357	1,180	1,819	1,850	2,923	7,306	1,326	23
Freshwater drum	905	2,032	1,825	1,180				290	4,206	111	39,673	48,218	8,823	24,507	265
Gars									441	68		27	90	279	
Suckers	1,378	123	88								436	4,286	72	6,180	1,945
Goldfish			551	188	2,951	877	8,416	1,025	501	111	517	7,138	10,497	6,862	
Carp	738,857	367,310	685,395	417,365	194,320	158,151	198,294	251,365	238,805	94,662	329,262	387,671	325,433	620,015	211,055
Quillback	87,326	2,217	1,062	1,380	568		6,894	30,204	28,175	8,930	66,013	73,662	33,937	22,990	
Bigmouth buffalo	577	14,732	17,814	9,471	19,549	40,064						104	91,877	15,721	25,894
Totals	1,728,400	406,681	754,942	451,262	233,432	201,605	216,276	289,469	283,699	114,223	454,833	586,867	521,213	721,580	259,993

Source: USGS, 2001c.

Table I1-5: Revenue from Commercial Landings in the Michigan Waters of Lake Erie, 1985-1999

Species	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Gizzard shad	$241,450							$342	$40	$274	$1	$4,809	$1,714	$350	$744
Brown bullhead	$1,834	$1,888	$1,076	$1,355	$895	$123	$171	$122	$213	$185	$189	$209	$253	$599	$1,904
Channel catfish	$5,364	$6,453	$23,201	$9,114	$6,898	$1,215	$1,138	$1,569	$5,580	$3,628	$10,189	$14,236	$9,684	$9,281	$4,461
White perch							$4	$5			$42	$28	$2		
White bass	$1,219	$1,073	$3,209	$629	$488		$18	$374	$1,191	$1,474	$1,702	$2,661	$6,213	$1,074	$18
Freshwater drum	$89	$185	$187	$472				$28	$462	$22	$7,538	$7,714	$1,411	$4,168	$48
Gars										$17		$11	$45	$112	
Suckers	$155	$7	$6								$26	$256	$5	$371	$253
Goldfish			$827	$47	$495	$201	$1,689	$308	$126		$130	$2,929	$3,466	$2,745	
Carp	$85,409	$38,937	$79,199	$63,611	$26,000	$19,590	$23,794	$30,612	$31,044	$12,306	$36,222	$46,521	$45,562	$80,601	$27,438
Quillback	$5,086	$170	$106	$139	$227		$2,661	$12,856	$10,144	$3,130	$22,446	$26,516	$6,449	$4,598	
Bigmouth buffalo	$292	$6,060	$7,148	$3,975	$8,332	$16,358						$47	$40,425	$8,018	$11,913
Totals	$340,898	$54,773	$114,959	$79,342	$43,335	$37,487	$29,475	$46,216	$48,800	$21,036	$78,485	$105,937	$115,229	$111,917	$46,779

Source: USGS, 2001c.

I1-3.3 Recreational Fisheries

Recreational fishing is minimal in the lower portion of the River Raisin, and most fishing is concentrated in the lakes of the upper basin (Dodge, 1998). A combination of factors such as limited access and a public perception of the river as polluted contributes to the lack of recreational fishing in the river. The lower River Raisin does have good smallmouth bass habitat and experiences light to moderate fishing pressure. Because of logjams and other obstacles, bank and wading fishing tends to be more popular than boat fishing.

Recreational fishing in Lake Erie is more predominant. Recreational anglers spent about 175,000 noncharter days fishing the Michigan waters of Lake Erie in 1994 (Rakoczy and Svoboda, 1997). Their most commonly caught species were yellow perch and walleye (44 percent and 35 percent of the total harvest, respectively; Table I1-6). White bass, channel catfish, freshwater drum, and white perch made up most of the remaining catch. Total recreational hours averaged approximately 2 million between 1986 and 1994 (Table I1-6).

Table I1-6: Michigan Lake Erie Boat Fishery Angler Effort and Primary Species Catch April Through October, 1986 to 1998

	Angler Hours	Number of Yellow Perch Harvested	Number of Walleye Harvested
1986[a]	2,068,779	834,310	605,666
1987	2,455,903	619,112	902,378
1988[b]	4,362,452	318,786	1,996,824
1989	3,799,067	1,466,442	1,092,289
1990	2,482,242	770,507	780,508
1991[a]	805,294	378,716	132,322
1992	836,216	255,747	249,713
1993	935,249	473,580	270,376
1994	1,012,595	246,327	216,040
1995	na	343,240	107,909
1996	na	635,233	174,607
1997	na	529,435	112,400
1998	na	586,277	114,607

[a] May through October.
[b] May through September.
na = not available.
Sources: Rakoczy and Svoboda, 1997; Thomas and Haas, 2000.

I1-3.4 Other Water-Based Recreation

The River Raisin is used for other recreational activities such as canoeing, power boating, and hunting (Dodge, 1998). Although passage is complicated by six low-head dams in Monroe, canoeing activity occurs just upstream of Monroe. The current is gentle for easy nonpower boating, although flow may be too low at some times of the year. The town of Blissfield sponsors a canoe race each September. Motor boating is concentrated in the lakes of the upper portion of the River Raisin watershed and at the mouth of the River Raisin. Many private marinas are located downstream of the last dam on the river, and boaters access Lake Erie from the river.

Although limited, some hunting occurs along the River Raisin. The Sharonville State Game Area, located in Jackson and Washtenaw Counties, is managed for deer, small mammal, and fowl hunting. Waterfowl hunting includes wood duck and Canada goose. Other game areas managed for similar hunting opportunities are the Onsted State Game Area, the Somerset State Game Area, and the Lake Hudson State Recreation Area. In Monroe County, The Michigan Department of Natural Resources manages the Petersburg State Game area for deer and small game hunting.

❖ ***The Linesville, PA Spillway at Pymatuning State Park:---"Where Ducks Walk on Fishes' Backs"***

Carp swarm above and below the spillway. They compete with ducks and Canada geese for slices of bread tossed to them by visitors. The ducks clamor over the seemingly endless school of carp to get their share. The ducks actually walk on the back of the carp.

The Spillway is a popular recreational site where visitors bring old bread or buy it at a nearby concession stand. Birds and fish compete for the bread. The spillway is the outflow of a secondary impoundment at the 2500 acre Pymatuning reservoir / sanctuary that serves as fish propagation waters for the Linesville Fish Culture Station.

Source: http://www.sideroads.com/outdoors/spillway.html
Photos: © Lynne G. Tudor